PATENT ABSTRACTS OF JAPAN

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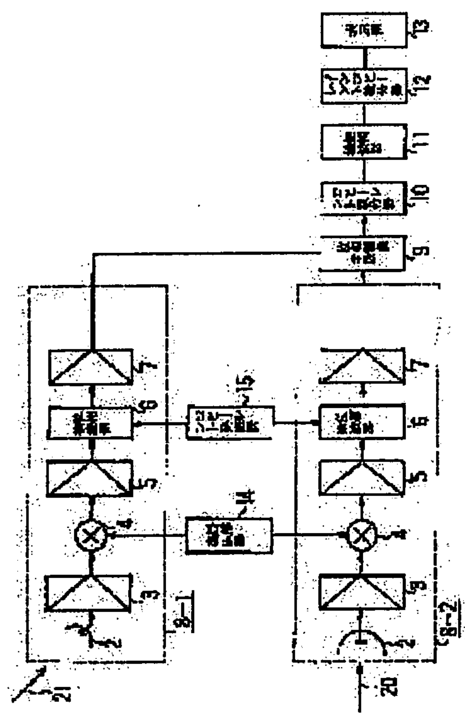
(54) MULTI-STATIC RADAR DEVICE



(57)Abstract:

PURPOSE: To obtain a multi-static radar device which is capable of maintaining the improvement effect of the signal/noise power ratio by the coherent integration without being affected by the frequency fluctuation of a local oscillator and a coherent oscilla tor of a transmitting station and a receiving station.

CONSTITUTION: A first receiving means 8-1 and a second receiving means 8-2 which make common use of a local oscillator 14 and a coherent oscillator 15 are provided. The first receiving means 8-1 outputs the signal by realizing frequency conversion and phase detection of the direct wave 21 from the transmitting station under the output of the respective oscillators, while the second receiving means 8-2 outputs the target signal by realizing frequency conversion and phase detection of the reflected wave from the target in a similar manner to the direct wave, then, a phase compensating means 9 compensates the phase fluctuation of the target signal outputted by the second receiving means 8-2 by using the signal of the first receiving means 8-1. Even if the oscillating frequencies of the transmitting station and the receiving station are fluctuated, the frequency of the target signal is not affected thereby, and the accuracy of the same degree is obtained with an inexpensive crystal oscillator as the case where a higher stable oscillator is used, leading to inexpensive manufacture of the device.

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CLAIMS

[Claim(s)]
[Claim 1] In the multi-static radar equipment which performs retrieval and tailing of a target using two or more sending stations arranged in a mutually different location, and a receiving station The 1st receiving means which carries out phase detection to a synchronous oscillation signal, and outputs a signal after receiving directly the RF electric wave emitted from the above-mentioned sending station, mixing a predetermined local oscillation frequency and changing into an intermediate frequency signal, The 2nd receiving means which carries out phase detection to the above-mentioned synchronous oscillation signal, and outputs a target signal after receiving the reflected wave which was emitted from the above-mentioned sending station and reflected by the target and changing into the above-mentioned intermediate frequency signal, Multi-static radar equipment characterized by having a phase compensation means to compensate phase fluctuation of the target signal outputted from the receiving means of the above 2nd, using the output signal of the receiving means of the above 1st.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the improvement in an improvement effect of the signal-to-noise power ratio by the coherent integral in multi-static radar equipment.
[0002]
[Description of the Prior Art] Drawing 3 is drawing showing the configuration of the conventional multi-static radar equipment shown in JP,1-217285,A, and is set to drawing. a time check for 33 to take the synchronization during transmission and reception -- the sending station which consisted of equipment 30, a transmitter 31, and a transmitting antenna 32 -- A target and 36 are emitted from a sending station 33, and 104 amplifies the reflected wave from the target received with the receiving antenna 2 which receives the electric wave reflected by the target 104, and the receiving antenna 2. The receiving station which consists of azimuth elevation angle computers 35 which compute the azimuth and elevation angle of a receiver 34 and a target to detect, and 39 are the location computer 37 which computes a target location, and the target-position drop which consisted of position indicators 38.
[0003] Moreover, drawing 4 is "AIRBORNE PULSED DOPPLERRADAR" Guy. V.Morris work Artech It is drawing showing the configuration of the conventional monostatic radar equipment which aimed at improvement in an improvement effect of the signal-to-noise power ratio by the coherent integral combining Fig3.8 and Fig13.26 which were indicated by 43 pages of House issuance, and 287 pages.
[0004]

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TECHNICAL FIELD

[Industrial Application] This invention relates to the improvement in an improvement effect of the signal-to-noise power ratio by the coherent integral in multi-static radar equipment.

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PRIOR ART

[Description of the Prior Art] Drawing 3 is drawing showing the configuration of the conventional multi-static radar equipment shown in JP,1-217285,A, and is set to drawing. a time check for 33 to take the synchronization during transmission and reception -- the sending station which consisted of equipment 30, a transmitter 31, and a transmitting antenna 32 -- A target and 36 are emitted from a sending station 33, and 104 amplifies the reflected wave from the target received with the receiving antenna 2 which receives the electric wave reflected by the target 104, and the receiving antenna 2. The receiving station which consists of azimuth elevation angle computers 35 which compute the azimuth and elevation angle of a receiver 34 and a target to detect, and 39 are the location computer 37 which computes a target location, and the target-position drop which consisted of position indicators 38.
[0003] Moreover, drawing 4 is "AIRBORNE PULSED DOPPLERRADAR" Guy. V.Morris work Artech It is drawing showing the configuration of the conventional monostatic radar equipment which aimed at improvement in an improvement effect of the signal-to-noise power ratio by the coherent integral combining Fig3.8 and Fig13.26 which were indicated by 43 pages of House issuance, and 287 pages.
[0004] The transceiver antenna with which, as for one in drawing, a transmission wave 22 and a transmission wave send and receive the reflected wave which was reflected by the target 104 and has returned, In 3, the high-frequency amplifier and 5 phase discriminator and 7 for the intermediate frequency amplifier and 6 A video amplifier, 10 an amplitude wave detector and 12 for a coherent integrator and 11 An incoherent integrator, The modulator with which the mixer by which in 13 a local oscillator and 15 compound coho and, as for 4, a drop and 14 compound the output of a local oscillator 14 and the output of coho, and 17 modulate transmitting amplifier for a side spur, and 18 modulates a transmission wave, and 19 are duplexers.
[0005] Next, the construction of the equipment which is needed in order to maintain the improvement effect of a signal-to-noise power ratio and this by the coherent integral at a good condition first according to drawing 4 is described. Frequency fc generated with coho 15 with this kind of equipment A signal and frequency fs generated with the local oscillator 14 After compounding a signal by the mixer 4 and changing into the signal of a frequency (fs+fc), it becomes irregular and amplifies with a modulator 18 and the transmitting amplifier 17, and emanates towards a target 104 through a duplexer 19 from the transceiver antenna 1.
[0006] It is reflected in a target 104, and the emitted transmission wave 22 turns into a reflected wave 20, and returns. the Doppler frequency fd by which it is decided according to a target radial rate at this time that the frequency of a reflected wave 20 will be the transmitted frequency having added (fs+fc+fd) -- it has become. After being again amplified with the high-frequency amplifier 3 through the transceiver antenna 1 and a duplexer 19, it is mixed with the output signal of a local oscillator 14 by the mixer 4, and this reflected wave 20 is from that frequency (fs+fc+fd). - It is fs. It is carried out and is changed into (fc+fd).
[0007] Furthermore, after being amplified with the intermediate frequency amplifier 5, it is mixed with the output signal of coho 15 with phase discriminator 6, and it is from the frequency (fc+fd). - fc It is

carried out and is the target Doppler frequency fd after all. It is left behind. After the output signal of phase discriminator 6 is amplified by the video amplifier 7, it is inputted into the Doppler filter bank prepared for the coherent integrator 10, and an integral is performed. The signal after a coherent integral is detected with the amplitude wave detector 11, and after integrating the incoherent integrator 12 again, it is displayed on a drop 13.

[0008] Since the local oscillator 14 and the coherent integrator 15 are shared by transmission and reception with the above-mentioned configuration, it is the frequency fs of each output signal. And fc Even if it changes, the effect will be mutually negated in the case of transmission and reception, and there will almost be no effect on the coherent storage effect.

[0009] However, with multi-static radar equipment, as shown in drawing 3 , since it is arranged in a location which is different in a sending station 33 and a receiving station 36, common use of a local oscillator 14 and coho 15 as shown in drawing 4 becomes impossible. For this reason, the frequency drift of two oscillators becomes ** and the cause of degradation of the coherent storage effect.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, since according to this invention it constituted so that phase fluctuation of the target signal which used the output signal of the 1st receiving means, and was amplified and detected with the 2nd receiving means could be compensated, even if it uses a cheap oscillator like a crystal oscillator, equipment can be manufactured, without reducing the improvement effect of the signal-to-noise power ratio by the coherent integral.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Takayasu it is required to make small frequency variation of a local oscillator and coho, in order to maintain the improvement effect of the signal-to-noise power ratio by the coherent integral, since conventional multi-static radar equipment is constituted as mentioned above, and using caesium or a rubidium -- a law -- since an oscillator is needed and the device for losing an oscillation and temperature fluctuation of equipment is needed further, equipment is expensive -- and there was a trouble of enlarging.
[0011] This invention was made in order to cancel the above troubles, and it aims at obtaining the multi-static radar equipment which can maintain the improvement effect of the signal-to-noise power ratio by coherent integral sufficient with the local oscillator and coho of stability of crystal-oscillator extent.

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MEANS

[Means for Solving the Problem] The 1st receiving means which carries out phase detection to a synchronous oscillation signal, and outputs a signal after receiving directly the RF electric wave emitted from the above-mentioned sending station, mixing a predetermined local oscillation frequency and changing into an intermediate frequency signal, The 2nd receiving means which carries out phase detection to the above-mentioned synchronous oscillation signal, and outputs a target signal after receiving the reflected wave which was emitted from the above-mentioned sending station and reflected by the target and changing into the above-mentioned intermediate frequency signal, A phase compensation means to compensate phase fluctuation of the target signal outputted from the receiving means of the above 2nd is established using the output signal of the receiving means of the above 1st.

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OPERATION

[Function] Since the phase compensation means in this invention compensates phase fluctuation of the output signal of the 2nd receiving means, i.e., a target signal, using the output signal of the 1st receiving means, even if it produces a gap in the oscillation frequency of the local oscillator of a sending station and a receiving station, and a syncsignal generator, it can compensate this. Therefore, it is necessary to use neither caesium nor a rubidium, a crystal oscillator as well as monostatic radar equipment becomes available as the above-mentioned oscillator, and it becomes possible to manufacture equipment cheaply.

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EXAMPLE

[Example]
The same part as drawing 4 explains one example of this invention according to drawing 1 using the same sign below example 1. In drawing 1 , 1st receiving means by which 8-1 consisted of a receiving antenna 2, the high-frequency amplifier 3, a mixer 4, intermediate frequency amplifier 5, phase discriminator 6, and a video amplifier 7, the 2nd receiving means according [8-2] to the same configuration, a phase compensation means by which 9 compensates phase fluctuation of the output signal of the 2nd receiving means 8-2 using the output signal of the 1st receiving means 8-1, and 21 are direct waves.
[0015] Drawing 2 is drawing showing the sending station of multi-static radar equipment, and target physical relationship, and, as for a receiving station, and 101, 102 and 103, 100 is [a sending station and 104] targets. Other signs show a component conventionally the same as that of equipment, or equivalent.
[0016] Hereafter, according to a drawing, actuation of the multi-static radar equipment of this invention is explained according to drawing. Generally with this kind of equipment, retrieval and tailing of a target are performed using two or more sending stations 101-103 and single receiving stations 100 which have been arranged in a location which is mutually different as shown in drawing 2 . Since this invention is applicable to the combination of the sending station of the arbitration of these, and a receiving station, by the following explanation, a sending station and a receiving station state one combination respectively.
[0017] Other parts are reflected by the target 104 and the transmission wave emitted from the sending station 101 is received by the 2nd receiving means 8-2 as a reflected wave 20 while the part is received by the 1st receiving means 8-1 of a receiving station 100 as a direct wave 21.
[0018] At this time, the frequency in the time of day t of the arbitration of the transmission wave reflected from the sending station 101 is set to fTX (t), and it is fSTALO, respectively about the oscillation frequency of the local oscillator 14 of a receiving station 100, and coho 15. It is referred to as (t) and fCOHO (t). It is the Doppler frequency fd with which it serves as fTX (t) since the frequency of a direct wave 21 is in agreement with the frequency of a transmission wave, and it is decided at the **** rate of a target 104, a sending station 101, and a receiving station 100 that the frequency of a reflected wave 20 will be. Since only (t) is changed, it is fTX(t)+fd. It is set to (t).
[0019] Therefore, they are magnification and the frequency f1 of a direct wave by which phase detection was carried out by the 1st receiving means 8-1. (t) is given by the formula 1.
f1 (t)=fTX(t)-fLATLO (t)-fCOHO(t) (1)
[0020] Moreover, they are magnification and the frequency f2 of a reflected wave by which phase detection was carried out by the 2nd receiving means 8-2. (t) is given by the formula 2.
f2 (t)=fd (t)+fTX(t)-fSTALO (t)-fCOHO(t)
(2)
[0021] It is inputted into the phase compensation means 9, the reflected wave, i.e., the target signal, amplified and detected with the 2nd receiving means 8-2, and compensates using the output signal of the

1st receiving means 8-1, time amount change, i.e., the frequency, of the phase. Frequency f3 of the target signal after phase compensation (t) is given by the formula 3.

f3 (t)=f2 (t)-f1 (t)=fd (t) (3)

[0022] It is the frequency f3 of the target signal after phase compensation by compensating phase fluctuation of a target signal in the phase compensation means 9 using the output signal of the 1st receiving means 8-1 so that more clearly than a formula 3. (t) is transmit frequencies fTX (t) and the oscillation frequency fSTALO of the local oscillator of a receiving station. It becomes unrelated to the oscillation frequency fCOHO of (t) and coho (t). Therefore, as well as monostatic radar equipment even if it changes these frequencies, it is not influenced [the] and becomes usable [a cheap crystal oscillator].

[0023] After carrying out amplitude detection with the amplitude wave detector 11 after the coherent integral was carried out with the coherent integrator 10, and integrating with the target signal after phase compensation again with the incoherent integrator 12, it is displayed on a drop 13.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of the multi-static radar equipment by one example of this invention.
[Drawing 2] They are the sending station in multi-static radar equipment, a receiving station, and the plot plan showing arrangement of a target.
[Drawing 3] It is the block diagram showing the configuration of conventional multi-static radar equipment.
[Drawing 4] It is the block diagram showing the configuration of monostatic radar equipment.
[Description of Notations]
8-1 1st Receiving Means
8-2 2nd Receiving Means
9 Phase Compensation Means
14 Local Oscillator
15 Coho
20 Reflected Wave
21 Direct Wave

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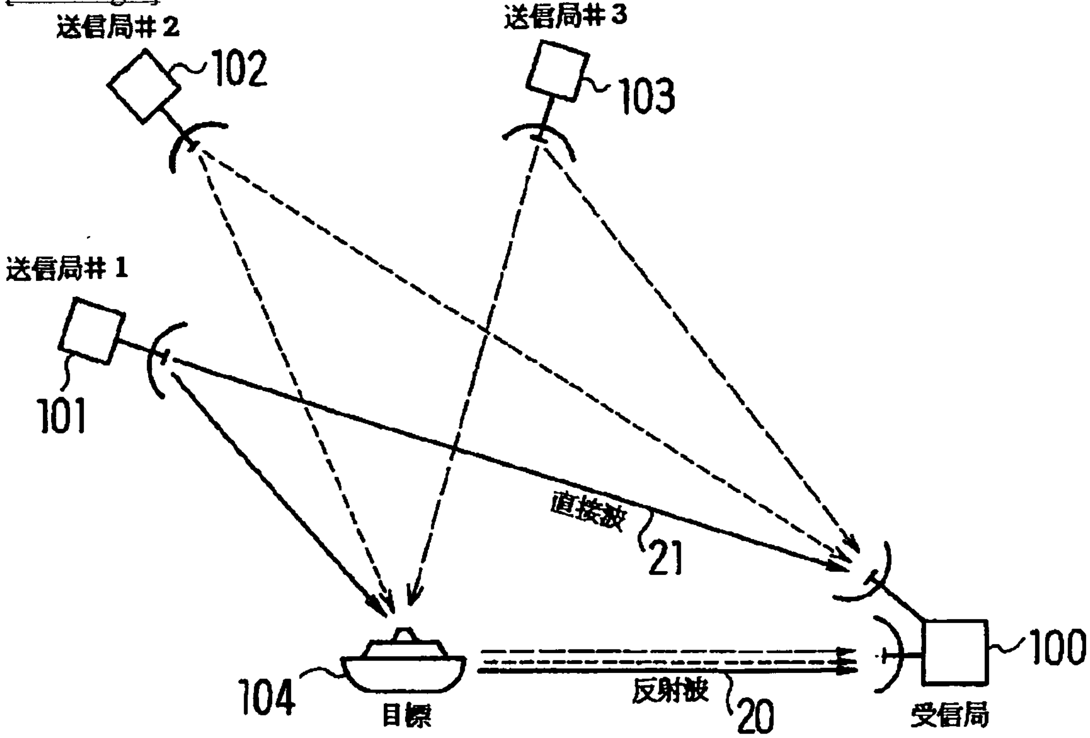
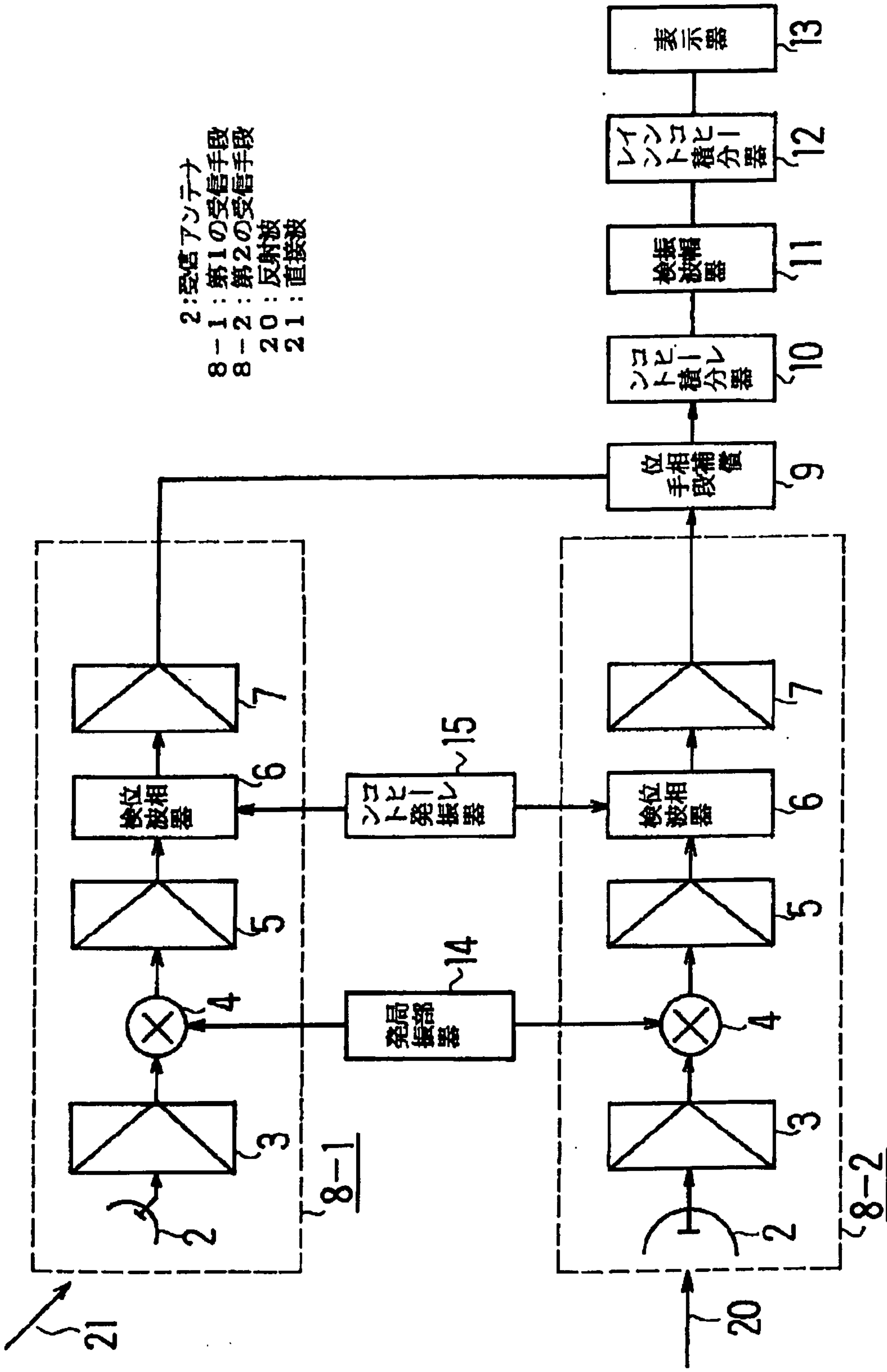
DRAWINGS

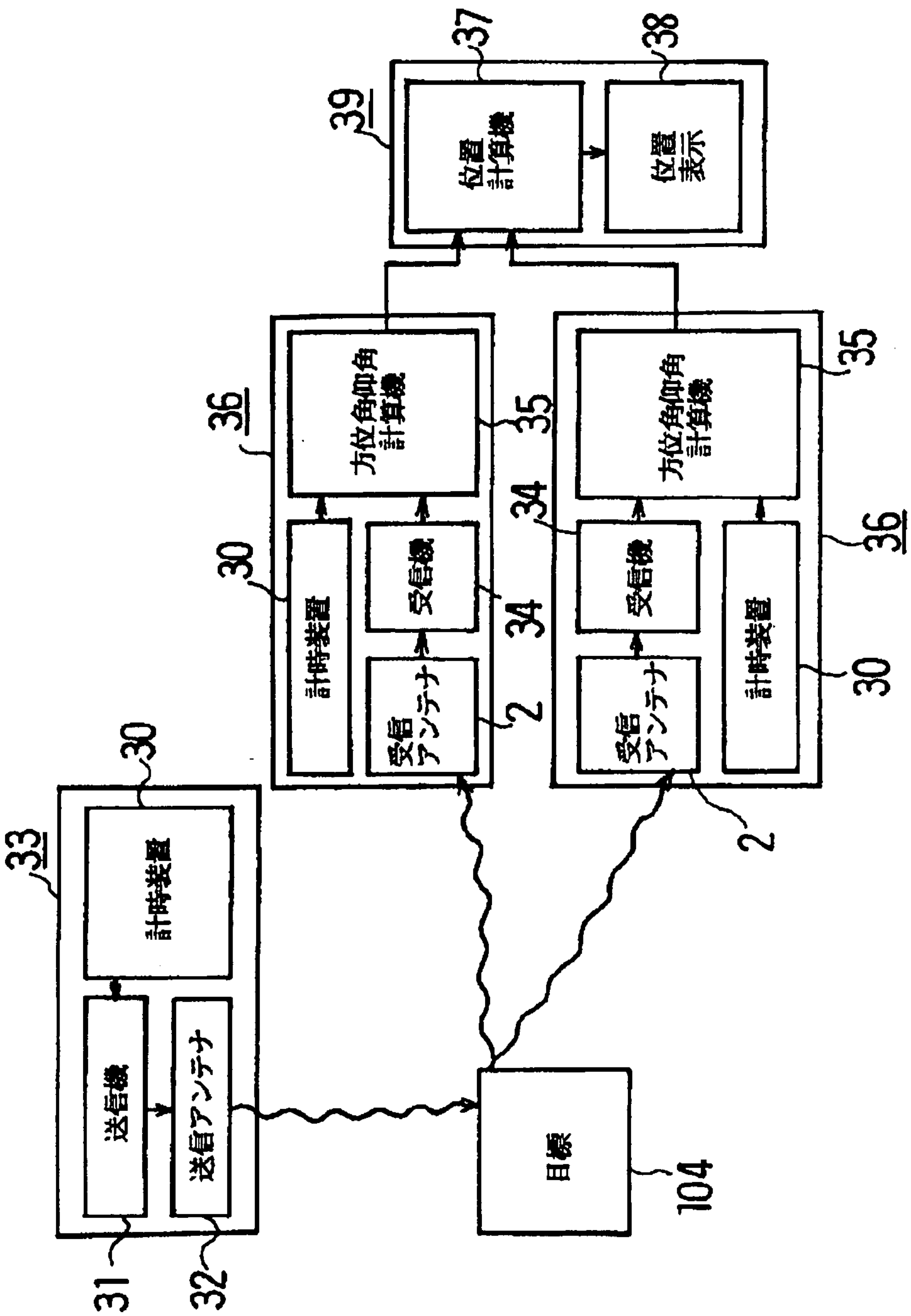
[Drawing 2]



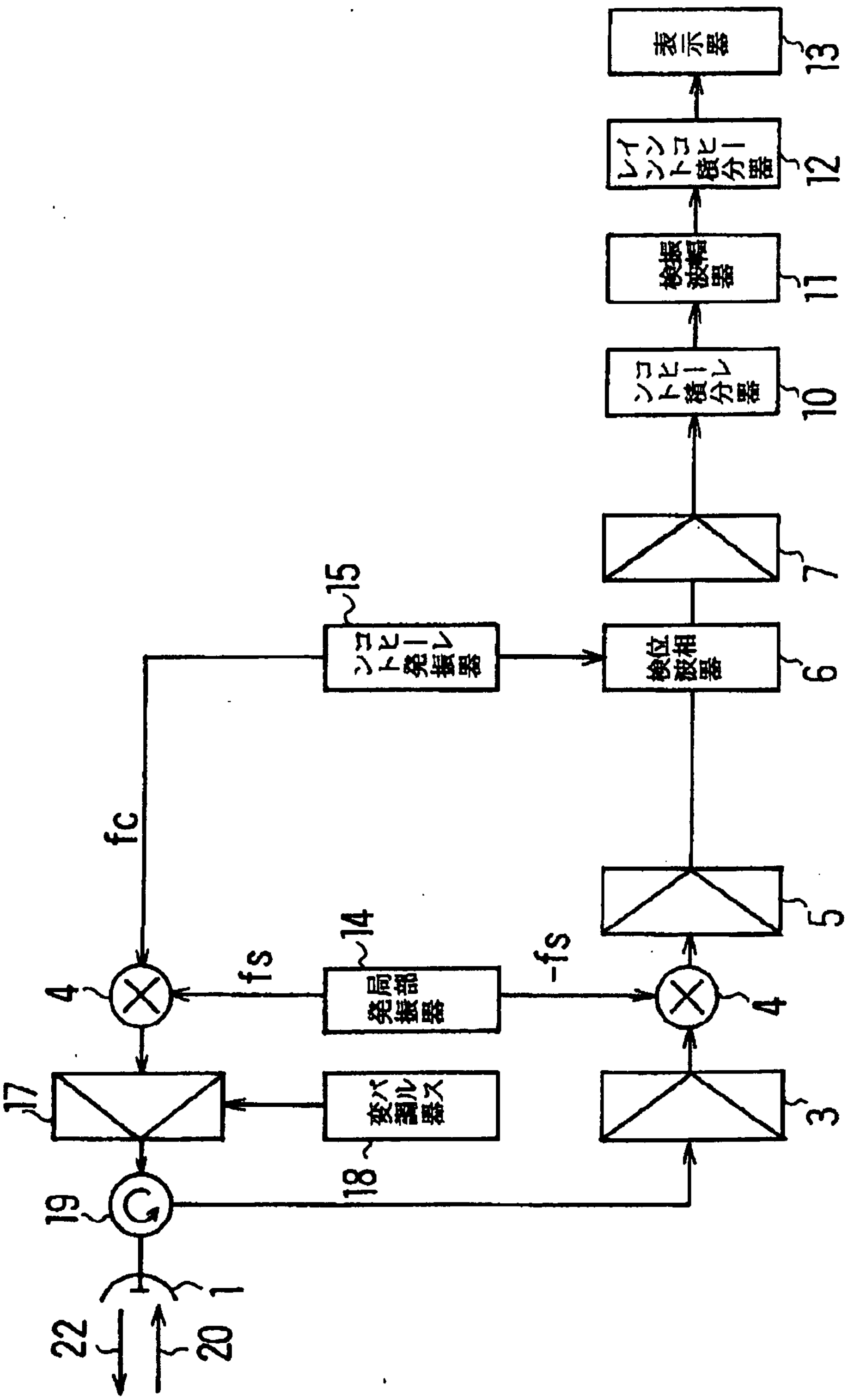
[Drawing 1]



[Drawing 3]


39
37
位置計算機
38
位置表示
36
35
方位角仰角計算機
30
計時装置
34
受信機
2
受信アンテナ
33
計時装置
送信機
送信アンテナ
31
32
目標
104

[Drawing 4]



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